

CLAIMS

We claim:

1. A process for regenerating catalyst in a reaction system, wherein the process comprises the steps of:
 - (a) contacting an oxygenate with a molecular sieve catalyst composition in a reactor under conditions effective to convert the oxygenate to light olefins and to form an at least partially coked molecular sieve catalyst composition;
 - (b) directing the at least partially coked molecular sieve catalyst composition from the reactor to a catalyst regenerator;
 - (c) directing an oxygen-containing regeneration medium from an air separation unit to the catalyst regenerator;
 - (d) contacting the regeneration medium with the at least partially coked molecular sieve catalyst composition in the catalyst regenerator under conditions effective to at least partially regenerate the at least partially coked molecular sieve catalyst composition and form a regenerated catalyst composition; and
 - (e) directing the regenerated catalyst composition from the catalyst regenerator to the reactor.
2. The process of claim 1, wherein the regeneration medium has a temperature of from about 16°C to about 149°C at a point immediately before the regeneration medium is introduced into the catalyst regenerator.
3. The process of claim 2, wherein the regeneration medium has a temperature of from about 27°C to about 93°C at a point immediately before the regeneration medium is introduced into the catalyst regenerator.

4. The process of claim 1, wherein the air separation unit forms an oxygen stream, a nitrogen stream and a compressed air stream, and wherein the regeneration medium comprises at least a portion of the oxygen stream.
5. The process of claim 2, wherein the regeneration medium further comprises at least a portion of the nitrogen stream.
6. The process of claim 5, wherein the regeneration medium has an oxygen to nitrogen weight ratio of from about 0.05 to about 10 wt/wt.
7. The process of claim 6, wherein the regeneration medium has an oxygen to nitrogen weight ratio of from about 0.1 to about 1.0 wt/wt.
8. The process of claim 7, wherein the regeneration medium has an oxygen to nitrogen weight ratio of from about 0.2 to about 0.5 wt/wt.
9. The process of claim 2, wherein step (e) comprises contacting the regenerated molecular sieve catalyst composition with a fluidizing stream under conditions effective to transport the regenerated molecular sieve catalyst composition in a fluidized manner from the catalyst regenerator to the reactor, wherein the fluidizing stream comprises at least a portion of the nitrogen stream.
10. The process of claim 2, wherein the reactor comprises a reaction zone and a disengaging zone, wherein the process further comprises the steps of:
 - (a) directing the molecular sieve catalyst composition from the reaction zone to the disengaging zone;
 - (b) yielding an olefin-containing effluent stream from the disengaging zone;
 - (c) directing the molecular sieve catalyst composition from the disengaging zone to a standpipe, which is in fluid communication with the reaction zone; and

- (d) contacting the molecular sieve catalyst composition with a fluidizing stream in the standpipe under conditions effective to transport the molecular sieve catalyst composition in a fluidized manner from the standpipe to the reaction zone, wherein the fluidizing stream comprises at least a portion of the nitrogen stream.
11. The process of claim 10, wherein the effluent stream further comprises a polymerization catalyst poison, the process further comprising the steps of:
- (a) contacting at least a portion of the effluent stream with a molecular sieve particle under conditions effective to adsorbatively remove the polymerization catalyst poison therefrom and to form a poison-containing molecular sieve particle; and
 - (b) contacting the poison-containing molecular sieve particle with at least a portion of the nitrogen stream under conditions effective to regenerate the poison-containing molecular sieve particle.
12. The process of claim 10, wherein the effluent stream further comprises an unsaturated compound selected from the group consisting of acetylene, methyl acetylene, butadiene and propadiene, the process further comprising the steps of:
- (a) contacting the unsaturated compound with a metal activated catalyst and a hydrogenation medium under conditions effective to hydrogenate the unsaturated compound and to form an at least partially coked metal activated catalyst; and
 - (b) contacting the at least partially coked metal activated catalyst with a second regeneration medium under conditions effective to convert the at least partially coked metal activated catalyst to a regenerated metal activated catalyst, wherein the second regeneration medium comprises at least a portion of the oxygen stream or at least a portion of the compressed air stream.

13. The process of claim 2, wherein the reactor comprises a reaction zone and a disengaging zone, and wherein step (b) comprises directing the at least partially coked molecular sieve catalyst from the disengaging zone to the catalyst regenerator.
14. The process of claim 2, wherein the process further comprises the step of:
 - (a) operating a valve actuator with a portion of the compressed air stream such that the valve actuator is operable to open or close a valve.
15. The process of claim 14, wherein the valve controls temperature of a process stream by modulating the flow rate of a heat exchanging medium.
16. The process of claim 15, wherein the valve is operable to control the temperature of the oxygenate before step (a).
17. The process of claim 14, wherein the valve is operable to control pressure of a process gas stream.
18. The process of claim 14, wherein the valve controls the flow rate of one or more process streams.
19. The process of claim 18, wherein the one or more process streams comprise a heat exchanging medium that heats a reboiler stream.
20. The process of claim 18, wherein the one or more process streams comprise a heat exchanging medium that cools a condenser stream.
21. The process of claim 2, wherein the oxygenate comprises methanol, the process further comprising the steps of:
 - (a) contacting natural gas with at least a portion of the oxygen stream in a syngas generator under conditions effective to convert the natural gas to syngas; and

- (b) contacting the syngas with a methanol synthesis catalyst in a methanol synthesis unit under conditions effective to convert at least a portion of the syngas to the methanol.
22. The process of claim 21, wherein the natural gas comprises H_2S , the process further comprising the steps of:
- (a) separating a majority of the H_2S from the natural gas to form a separated H_2S -containing stream;
 - (b) contacting the separated H_2S -containing stream with a portion of the oxygen stream or with a portion of the compressed air stream under conditions effective to convert a portion of the H_2S in the separated H_2S -containing stream to SO_2 ; and
 - (c) contacting the SO_2 with residual H_2S in the presence of a catalyst composition under conditions effective to form elemental sulfur and water.
23. The process of claim 21, wherein the natural gas comprises water, the process further comprising the steps of:
- (a) contacting at least a portion of the natural gas with a molecular sieve particle under conditions effective to adsorbatively remove the water therefrom and form a water-containing molecular sieve particle; and
 - (b) contacting the water-containing molecular sieve particle with at least a portion of the nitrogen stream under conditions effective to regenerate the water-containing molecular sieve particle.
24. The process of claim 2, wherein the process further comprises the steps of:
- (a) contacting at least a portion of the light olefins with a polymerization catalyst under conditions effective to form a polymer; and
 - (b) contacting the polymer with at least a portion of the nitrogen stream under condition effective to remove volatile compounds from the polymer.

25. The process of claim 2, wherein the process further comprises the steps of:
 - (a) contacting at least a portion of the light olefins with a polymerization catalyst under conditions effective to form a polymer; and
 - (b) blanketing the polymer with at least a portion of the nitrogen stream.
26. The process of claim 25, wherein the polymer comprises polymer pellets.
27. The process of claim 2, wherein the process further comprises the step of:
 - (a) deriming a turboexpander in the reaction system by adding a portion of the nitrogen stream to the turboexpander.
28. The process of claim 2, wherein the process further comprises the step of:
 - (a) deriming a cold box in the reaction system by adding a portion of the nitrogen stream to the cold box.
29. The process of claim 2, wherein the process further comprises the step of:
 - (a) contacting at least a portion of the molecular sieve catalyst composition with a fluidizing stream under conditions effective to transport the at least a portion of the molecular sieve catalyst composition in a fluidized manner from the reaction system to a catalyst storage unit, wherein the fluidizing stream comprises one or more of at least a portion of the oxygen stream, at least a portion of the nitrogen stream or at least a portion of the compressed air stream.
30. The process of claim 29, wherein the process further comprises the step of:
 - (a) blanketing the at least a portion of the molecular sieve catalyst composition in the catalyst storage unit with a blanketing medium selected from the group consisting of at least a portion of the nitrogen stream, at least a portion of the oxygen stream, at least a portion of the compressed air stream, and combinations thereof.

31. The process of claim 2, wherein the process further comprises the step of:
 - (a) directing at least a portion of the oxygen stream or the compressed air stream from the air separation unit to an aerobic water treatment system for removing contaminants from a water-containing effluent stream.

32. A process for forming light olefins from an integrated reaction system, wherein the process comprises the steps of:
 - (a) separating air components in an air separation unit to form an oxygen stream and a nitrogen stream, wherein the air separation unit also forms a compressed air stream;
 - (b) contacting natural gas with at least a portion of the oxygen stream in a syngas generator under conditions effective to convert the natural gas to syngas;
 - (c) contacting the syngas with a first catalyst composition in a methanol synthesis unit under conditions effective to convert at least a portion of the syngas to methanol;
 - (d) contacting the methanol with a molecular sieve catalyst composition in a reaction zone under conditions effective to convert the methanol to light olefins;
 - (e) directing the light olefins and the molecular sieve catalyst composition to a disengaging zone;
 - (f) yielding an effluent stream comprising the light olefins from the disengaging zone;
 - (g) directing the molecular sieve catalyst composition to a standpipe; and
 - (h) contacting the molecular sieve catalyst composition with a first fluidizing stream in the standpipe under conditions effective to transport the molecular sieve catalyst composition in a fluidized manner from the standpipe to the reaction zone, wherein the first fluidizing stream comprises at least a portion of the oxygen stream, at least a portion of the nitrogen stream or at least a portion of the compressed air stream.

33. The process of claim 32, wherein the first fluidizing stream comprises at least a portion of the nitrogen stream.
34. The process of claim 32, wherein the process further comprises the steps of:
- (a) directing an at least partially coked molecular sieve catalyst composition from the reaction zone or the disengaging zone to a catalyst regenerator;
 - (b) contacting the at least partially coked molecular sieve catalyst composition with a regeneration medium in the catalyst regenerator under conditions effective to convert the at least partially coked molecular sieve catalyst composition to a regenerated molecular sieve catalyst composition, wherein the regeneration medium comprises at least a portion of the oxygen stream or at least a portion of the compressed air stream; and
 - (c) directing the regenerated molecular sieve catalyst composition to the reaction zone or the disengaging zone.
35. The process of claim 34, wherein step (k) comprises contacting the regenerated molecular sieve catalyst composition with a second fluidizing stream under conditions effective to transport the regenerated molecular sieve catalyst composition in a fluidized manner from the catalyst regenerator to the reaction zone or the disengaging zone, wherein the second fluidizing stream comprises at least a portion of the nitrogen stream.
36. The process of claim 32, wherein the process further comprises the step of:
- (a) contacting at least a portion of the molecular sieve catalyst composition with a second fluidizing stream under conditions effective to transport the at least a portion of the molecular sieve catalyst composition in a fluidized manner from the reaction system to a catalyst storage unit, wherein the second fluidizing stream comprises one or more of at least a

portion of the oxygen stream, at least a portion of the nitrogen stream or at least a portion of the compressed air stream.

37. The process of claim 36, wherein the process further comprises the step of:
- (a) blanketing the at least a portion of the molecular sieve catalyst composition in the catalyst storage unit with a blanketing medium selected from the group consisting of at least a portion of the nitrogen stream, at least a portion of the oxygen stream, at least a portion of the compressed air stream, and combinations thereof.
38. A process for forming light olefins from an integrated reaction system, wherein the process comprises the steps of:
- (a) separating air components in an air separation unit to form an oxygen stream and a nitrogen stream, wherein the air separation unit also forms a compressed air stream;
 - (b) providing a natural gas-containing stream comprising natural gas and H_2S ;
 - (c) separating a majority of the H_2S from the natural gas-containing stream to form a separated H_2S -containing stream;
 - (d) contacting the separated H_2S -containing stream with a portion of the oxygen stream or with a portion of the compressed air stream under conditions effective to convert a portion of the H_2S in the separated H_2S -containing stream to SO_2 ;
 - (e) contacting the SO_2 with residual H_2S in the presence of a catalyst composition under conditions effective to form elemental sulfur and water;
 - (f) contacting the natural gas in the natural gas-containing stream with at least a portion of the oxygen stream in a syngas generator under conditions effective to convert the natural gas to syngas;
 - (g) contacting the syngas with a first catalyst composition in a methanol synthesis unit under conditions effective to convert at least a portion of the syngas to methanol; and

- (h) contacting the methanol with a molecular sieve catalyst composition in a reactor under conditions effective to convert the methanol to light olefins.
39. The process of claim 38, wherein the process further comprises the steps of:
- (a) directing an at least partially coked molecular sieve catalyst composition from the reactor to a catalyst regenerator, wherein the reactor comprises a reaction zone and a disengaging zone;
 - (b) contacting the at least partially coked molecular sieve catalyst composition with a regeneration medium in the catalyst regenerator under conditions effective to convert the at least partially coked molecular sieve catalyst composition to a regenerated molecular sieve catalyst composition, wherein the regeneration medium comprises at least a portion of the oxygen stream or at least a portion of the compressed air stream; and
 - (c) directing the regenerated molecular sieve catalyst composition to the reactor.
40. The process of claim 39, wherein step (i) comprises directing the at least partially coked catalyst from the disengaging zone to the catalyst regenerator.
41. The process of claim 38, wherein the reactor comprises a reaction zone and a disengaging zone, the process further comprising the steps of:
- (a) directing the molecular sieve catalyst composition from the reaction zone to the disengaging zone;
 - (b) yielding an effluent stream comprising the light olefins from the disengaging zone;
 - (c) directing the molecular sieve catalyst composition from the disengaging zone to a standpipe, which is in fluid communication with the reaction zone; and

- (d) contacting the molecular sieve catalyst composition with a fluidizing stream in the standpipe under conditions effective to transport the molecular sieve catalyst composition in a fluidized manner from the standpipe to the reaction zone, wherein the fluidizing stream comprises at least a portion of the oxygen stream, at least a portion of the nitrogen stream or at least a portion of the compressed air stream.
42. A process for forming a polymer, wherein the process comprises the steps of:
- (a) separating air components in an air separation unit to form an oxygen stream and a nitrogen stream, wherein the air separation unit also forms a compressed air stream;
 - (b) contacting an oxygenate with a molecular sieve catalyst composition in an oxygenate-to-olefins reaction system under conditions effective to convert the oxygenate to light olefins;
 - (c) yielding an effluent stream comprising the light olefins from the oxygenate-to-olefins reaction system;
 - (d) combining at least a portion of the nitrogen stream with at least a portion of the effluent stream to form a polymerization feedstock; and
 - (e) contacting a polymerization catalyst with the polymerization feedstock in a polymerization unit under conditions effective to form the polymer.
43. The process of claim 42, wherein the process further comprises the step of:
- (a) contacting the polymer with at least a portion of the nitrogen stream under condition effective to remove volatile compounds from the polymer.
44. The process of claim 42, wherein the process further comprises the step of:
- (a) blanketing the polymer with a portion of the nitrogen stream.

45. The process of claim 42, wherein the process further comprises the steps of:
- (a) extruding the polymer to form an extruded polymer;
 - (b) cutting the extruded polymer to form polymer pellets;
 - (c) blanketing the polymer pellets with at least a portion of the nitrogen stream; and
 - (d) cooling the polymer pellets.
46. The process of claim 42, wherein the process further comprises the step of:
- (a) contacting syngas with a first catalyst composition in an oxygenate synthesis unit under conditions effective to convert at least a portion of the syngas to the oxygenate.
47. The process of claim 46, wherein the process further comprises the step of:
- (a) contacting natural gas with at least a portion of the oxygen stream in a syngas generator under conditions effective to convert the natural gas to the syngas.
48. An integrated reaction system for forming light olefins, wherein the integrated reaction system comprises:
- (a) an air separation unit comprising one or more separation columns for separating air into an oxygen stream and a nitrogen stream, wherein the air separation unit also forms a compressed air stream;
 - (b) a syngas generator in fluid communication with the air separation unit and in which natural gas contacts at least a portion of the oxygen stream under conditions effective to convert the natural gas to syngas;
 - (c) a methanol synthesis unit in fluid communication with the syngas generator, wherein the syngas contacts a first catalyst composition in the methanol synthesis unit under conditions effective to convert at least a portion of the syngas to methanol;
 - (d) a methanol-to-olefins reaction unit in fluid communication with the methanol synthesis unit, wherein the methanol contacts a molecular sieve

catalyst composition in the methanol-to-olefins reaction unit under conditions effective to convert the methanol to light olefins and to form an at least partially coked molecular sieve catalyst composition; and

(e) a catalyst regenerator in fluid communication with the methanol-to-olefins reaction unit, wherein the at least partially coked molecular sieve catalyst composition contacts a regeneration medium in the catalyst regenerator under conditions effective to convert the at least partially coked molecular sieve catalyst composition to a regenerated molecular sieve catalyst composition, wherein the catalyst regenerator is in fluid communication with the air separation unit, and wherein the regeneration medium comprises at least a portion of the oxygen stream or at least a portion of the compressed air stream.

49. The system of claim 48, wherein the regeneration medium further comprises at least a portion of the nitrogen stream.
50. The system of claim 48, wherein the regeneration medium comprises at least a portion of the oxygen stream.
51. The system of claim 48, wherein the regeneration medium comprises at least a portion of the compressed air stream.
52. The system of claim 48, wherein the system further comprises:
 - (a) a conduit for delivering regenerated catalyst from the catalyst regenerator to the methanol-to-olefins reaction unit, wherein the conduit comprises a fluidizing opening for receiving a fluidizing stream from the air separation unit, wherein the regenerated molecular sieve catalyst composition contacts the fluidizing stream in the conduit under conditions effective to transport the regenerated molecular sieve catalyst composition in a fluidized manner from the catalyst regenerator to the methanol-to-olefins reaction unit, and wherein the fluidizing stream comprises at least a portion of the nitrogen stream.

53. The system of claim 48, wherein the methanol-to-olefins reaction unit comprises a reaction zone and a disengaging zone, wherein the system further comprises:
- (a) a standpipe for transporting catalyst from the disengaging zone to the reaction zone, wherein the standpipe comprises a fluidizing opening for receiving a fluidizing stream from the air separation unit, wherein the molecular sieve catalyst composition contacts the fluidizing stream in the standpipe under conditions effective to transport the molecular sieve catalyst composition in a fluidized manner from the disengaging zone to the reaction zone, and wherein the fluidizing stream comprises at least a portion of the nitrogen stream.
54. The system of claim 48, wherein the methanol-to-olefins reaction unit comprises a reaction zone and a disengaging zone, and wherein a conduit directs the at least partially coked molecular sieve catalyst composition from the disengaging zone to the catalyst regenerator.
55. The system of claim 54, wherein the conduit comprises a fluidizing opening for receiving a fluidizing stream from the air separation unit, wherein the at least partially coked molecular sieve catalyst composition contacts the fluidizing stream in the conduit under conditions effective to transport the at least partially coked molecular sieve catalyst composition in a fluidized manner from the disengaging zone to the catalyst regenerator, and wherein the fluidizing stream comprises at least a portion of the oxygen stream.
56. The system of claim 54, wherein the conduit comprises a fluidizing opening for receiving a fluidizing stream from the air separation unit, wherein the at least partially coked molecular sieve catalyst composition contacts the fluidizing stream in the conduit under conditions effective to transport the at least partially coked molecular sieve catalyst composition

in a fluidized manner from the disengaging zone to the catalyst regenerator, and wherein the fluidizing stream comprises at least a portion of the compressed air stream.

57. The system of claim 48, wherein the system further comprises:
 - (a) a valve actuator in fluid communication with the air separation unit, wherein the valve actuator receives a portion of the compressed air stream such that the valve actuator is operable to open or close a valve.
58. The system of claim 57, wherein the valve controls temperature of a process stream by modulating the flow rate of a heat exchanging medium.
59. The system of claim 57, wherein the valve is operable to control pressure of a process gas stream.
60. The system of claim 57, wherein the valve controls the flow rate of one or more process streams in the integrated reaction system.
61. The system of claim 60, wherein the system further comprises:
 - (a) a conduit for directing the methanol from the methanol synthesis unit to the methanol-to-olefins reaction unit, wherein the one or more process streams comprise the methanol that is directed to the methanol-to-olefins reaction unit.
62. The system of claim 60, wherein the system further comprises:
 - (a) an oxygenate recovery unit for recovering an oxygenate from the effluent stream and to form an oxygenate-containing stream, wherein the one or more process streams comprise the oxygenate-containing stream; and
 - (b) a conduit directing the oxygenate-containing stream from the oxygenate recovery unit to the methanol-to-olefins reaction unit.

63. The system of claim 60, wherein the system further comprises:
(a) a heat exchanger for heating a reboiler stream with a heat exchanging medium, wherein the one or more process streams comprise the heat exchanging medium.
64. The system of claim 60, wherein the system further comprises:
(a) a heat exchanger for cooling a condenser stream with a heat exchanging medium, wherein the one or more process streams comprise the heat exchanging medium.
65. The system of claim 48, wherein the air separation unit comprises a main air compressor and a booster air compressor.
66. The system of claim 65, wherein the main air compressor comprises a plurality of compression stages, and wherein the main air compressor forms the compressed air stream.
67. The system of claim 48, wherein the system further comprises:
(a) a polymerization unit in fluid communication with the methanol-to-olefins reaction unit, wherein at least a portion of the light olefins contacts a polymerization catalyst in the polymerization unit under conditions effective to form a polymer.
68. The system of claim 67, wherein the system further comprises:
(a) a volatile component removal unit in fluid communication with the polymerization unit and the air separation unit, wherein the polymer contacts at least a portion of the nitrogen stream received from the air separation unit under conditions effective to remove volatile components from the polymer.

69. The system of claim 67, wherein the system further comprises:
- (a) an extruder in fluid communication with the polymerization unit for extruding the polymer to form an extruded polymer;
 - (b) a cutting device in fluid communication with the extruder for cutting the extruded polymer to form polymer pellets;
 - (c) a blanketing unit in fluid communication with the air separation unit and the cutting device, wherein the polymer pellets are blanketed with at least a portion of the nitrogen stream; and
 - (d) a cooling unit in fluid communication with the blanketing unit for cooling the polymer pellets.
70. The system of claim 48, wherein the system further comprises:
- (a) an adsorption unit wherein an effluent stream, which comprises the light olefins from the methanol-to-olefins reaction unit and a polymerization catalyst poison, contacts a molecular sieve particle under conditions effective to adsorbatively remove the polymerization catalyst poison therefrom and to form a poison-containing molecular sieve particle, wherein the adsorption unit is in fluid communication with the methanol-to-olefins reaction unit; and
 - (b) a regeneration unit in fluid communication with the air separation unit and the adsorption unit, wherein the poison-containing molecular sieve particle contacts at least a portion of the nitrogen stream under conditions effective to regenerate the poison-containing molecular sieve particle.
71. The system of claim 48, wherein the natural gas comprises H_2S , the system further comprising:
- (a) an absorption unit wherein a majority of the H_2S is removed from the natural gas to form a separated H_2S -containing stream;
 - (b) an SO_2 synthesis unit in fluid communication with the absorption unit, and wherein the separated H_2S -containing stream contacts a portion of the oxygen stream or with a portion of the compressed air stream under

conditions effective to convert a portion of the H_2S in the separated H_2S -containing stream to SO_2 ; and

(c) a sulfur synthesis unit in fluid communication with the air separation unit and the SO_2 synthesis unit, and wherein the SO_2 contacts residual H_2S in the presence of a catalyst composition under conditions effective to form elemental sulfur and water.

72. The system of claim 48, wherein the system further comprises:

(a) a turboexpander in fluid communication with the air separation unit, wherein the turboexpander is derivable by adding a portion of the nitrogen stream to the turboexpander.

73. The system of claim 48, wherein the system further comprises:

(a) a cold box in fluid communication with the air separation unit, wherein the cold box is derivable by adding a portion of the nitrogen stream to the cold box.

74. The system of claim 48, wherein the system further comprises:

(a) an aerobic water treatment system in fluid communication with the air separation unit, wherein the aerobic water treatment system receives at least a portion of the oxygen stream or at least a portion of the compressed air stream from the air separation unit, and wherein the aerobic water treatment system removes one or more contaminants from a water-containing effluent stream.